Composite Modulus: Rule of Mixtures (Voigt and Reuss Bounds)

Longitudinal (Voigt, iso-strain) and transverse (Reuss, iso-stress) modulus of a fibre composite, and its density, from fibre volume fraction and the constituents.

Method: Voigt (iso-strain) and Reuss (iso-stress) bounds of the rule of mixtures

Input parameters

Unit system: SI

Parameter	Value	Unit
Fibre volume fraction	55.000	%
Fibre modulus	72.000	GPa
Matrix modulus	3.2000	GPa
Fibre density	2,550.0	kg/m³
Matrix density	1,200.0	kg/m³

Calculated results

Parameter	Value	Unit
Longitudinal modulus (Voigt)	41.040	GPa
Transverse modulus (Reuss)	6.7447	GPa
Composite density	1,942.5	kg/m³

Notes for this case

- Upper and lower bounds; real transverse moduli lie above Reuss (Halpin–Tsai is closer).

Formula and method

$$E_L = V_f E_f + (1 - V_f) E_m, \quad \frac{1}{E_T} = \frac{V_f}{E_f} + \frac{1 - V_f}{E_m}$$

Variables

V_f	Fibre volume fraction	-
E_f	Fibre modulus	Pa
E_m	Matrix modulus	Pa
ρ_f	Fibre density	kg/m³
ρ_m	Matrix density	kg/m³
E_L	Longitudinal modulus (Voigt)	Pa
E_T	Transverse modulus (Reuss)	Pa
ρ_c	Composite density	kg/m³

Method and standards

Rule of mixtures.

Assumptions and limits

- Continuous aligned fibres, perfect bonding.

References

- Voigt (iso-strain) and Reuss (iso-stress) bounds of the rule of mixtures

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/properties/composite-modulus-bounds

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.